CLAIMS

What is claimed is:

1. A method for real-time measurement of the mass, size and number of particles defining particulate matter in exhaust gas discharged from an internal combustion engine, comprising:

discharging exhaust gas from the internal combustion engine over a predefined period of time while operating in a predetermined mode, the particulate matter contained in the discharged exhaust gas having a volatile fraction disposed primarily in a gaseous phase comprising unburned and partially burned fuel and lubricating oil, and sulfur compounds, and a solid fraction comprising particles of carbon and inorganic ash;

continuously collecting a first sample of the discharged exhaust gas throughout the predefined period of time;

directing the first sample of the exhaust gas through a catalytic stripper and removing at least about 90% of the volatile fraction from the first sample and passing at least about 95% of the solid fraction of the first sample through the catalytic stripper;

cooling the first sample of exhaust gas to a temperature of from about 25°C to about 52°C;

measuring the size and number of particulate matter contained in a

representative portion of the cooled first sample of exhaust gas over the predefined period of time, the measured size and number of particulate matter being representative of the distribution of particles defining the solid fraction of the particulate matter discharged from said engine over the predefined period of time;

collecting the particulate matter from the first sample of exhaust gas over the predefined period of time; and

measuring the mass of the collected particulate matter of the first sample, said measured mass being representative of the total mass of the solid fraction particulate matter discharged from said engine over the predefined period of time.

2. The method as set forth in Claim 1, wherein said method includes:

discharging exhaust gas from the internal combustion engine while operating in said predetermined mode over a predefined period of time comparable to the predefined period of time during which the first sample was collected ;

continuously collecting a second sample of the exhaust gas throughout the comparable period of time;

cooling the second sample of the exhaust gas to a temperature sufficient to precipitate substantially all of the volatile fraction from said gaseous phase to a liquid phase;

collecting the solid fraction and the precipitated liquid phase particles of the

volatile fraction formed throughout the comparable period of time; and

measuring the total mass of the collected solid fraction and the precipitated liquid phase of the volatile fraction, said measured mass being representative of the total particulate matter discharged from said engine during said comparable period of time.

3. The method as set forth in Claim 2, wherein said method includes:

calculating the difference between the mass of said first and second samples of exhaust gas, said difference being representative of the volatile fraction particulate matter contained in the exhaust gas discharged from said engine.

4. The method as set forth in Claim 2, wherein said method includes passing the discharged exhaust gas through a dilution tunnel and mixing the exhaust gas with air having a defined mass flow rate before continuously collecting the first and second samples.

5. The method as set forth in Claim 2, wherein cooling the first and second samples includes mixing the samples with air in a micro-dilution tunnel.

6. The method as set forth in Claim 5, wherein said collecting the solid particles of the first sample, and collecting the particles of the solid fraction and the precipitated liquid phase of the volatile fraction of the second sample, includes collecting the particles of the solid fraction and the precipitated liquid phase of the volatile fraction on a filter disposed downstream of the micro-dilution tunnel wherein said samples are cooled.

7. The method, as set forth in Claim 1, wherein cooling the first and second samples includes rapidly cooling the samples at a rate sufficient to impede the formation of sulfuric acid particles.

8. The method, as set forth in Claim 1, wherein measuring the size and number of particulate matter contained in a representative portion of the cooled first sample of exhaust gas over the predefined period of time includes passing the representative portion through a particle sizer adapted to determine the size of particulate matter in the representative portion of the first sample, and a particle counter adapted to measure the total number of particulate matter in the representative portion passing through the counter over said predefined time period.

9. The method, as set forth in Claim 1, wherein said method includes heating the catalytic stripper to a preselected temperature having a range of from about 250°C to about 500°C, and maintaining the catalytic stripper at said preselected temperature while passing the first sample of exhaust gas through the catalytic stripper.

10.An apparatus for real-time measurement of the mass, size and number of particles defining particulate matter in exhaust gas discharged from an internal combustion engine, comprising:

a catalytic stripper in fluid communication with an exhaust system of said engine and adapted to remove at least about 90% of a volatile fraction from the exhaust gas and pass at least 95% of a solid fraction of the exhaust gas through the catalytic stripper;

a micro-dilution tunnel in selective fluid communication with said catalytic stripper and adapted to mix air having a temperature less than that of the exhaust gas with the exhaust gas and form a mixture of air and exhaust gas having a temperature of less than about 52°C;

a particle sizer in fluid communication with said micro-dilution tunnel;

a particle counter in fluid communication with said micro-dilution tunnel;

a means for continuously collecting particulate matter contained in the mixture of air and exhaust gas over a predefined period of time; and

a means for measuring the mass of the particulate matter collected over said predefined period of time.

11.The apparatus as set forth in Claim 10, wherein said apparatus includes a dilution tunnel interposed between an exhaust system of said engine and said catalytic stripper, said dilution tunnel being adapted to mix air with the exhaust gas discharged from said engine and provide a mixture of air and exhaust gas to said catalytic stripper.

12.The apparatus as set forth in Claim 10, where said apparatus includes a means for controllably heating the catalytic stripper to a temperature having a range from about 250°C to about 500°C.

13.The apparatus as set forth in Claim 10, wherein said apparatus includes a means for measuring the mass flow of the mixture of air and exhaust gas from which the particulate matter has been collected by said means for continuously collecting particulate matter contained in the mixture of air and exhaust gas over a predefined period of time.